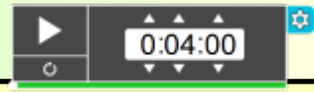
Energy, power and resistance	**The electron gun**

Learning objectives	**MUST (6)**	Describe uses for, and basic structure of, the electron gun
	SHOULD (7)	Explain how electron guns work
	COULD (8/9)	Calculate a value for the kinetic energy of an electron being emitted from an electron gun.

STARTER: How do old TV sets compare to new TV sets? (just think of the structure and image here - not smart functionality or channels available).

EXTENSION: What actually made the picture on older TV screens?



Oct 16-21:59

Energy, power and resistance	**Electron guns**
MUST (6)	Describe uses for, and basic structure of, an electron gun

Old TVs had a component named a **cathode ray tube**. This accelerated electrons towards a screen, which contained chemicals that would light up when hit by an electron.

A CRT is one type of **electron gun**, which produces a narrow beam of electrons with a precise kinetic energy.

Other uses for electron guns: CROs (cathode ray oscilloscopes), electron microscopes and particle accelerators.

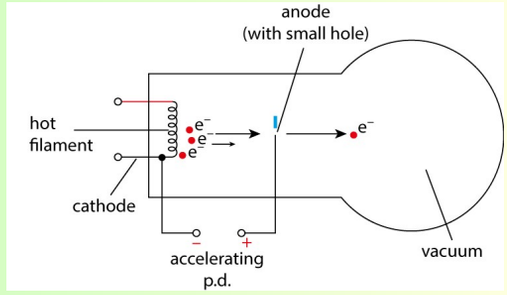
CRT TV in slow motion, 2:16 start, remember photosensitive warning

TV vs magnet

Energy, power and resistance	**Electron gun**
SHOULD (7)	Explain how an electron gun works

When an electron moves through a potential difference V, the work done on it (energy transferred) is eV (charge on the electron x potential difference)

1 eV ('electronvolt') is the amount of energy transferred to one electron moving across a 1 V potential difference.



Task

Use the guided worksheet to work out step-by-step how an electron gun works. If you need hints, just ask.

Extension: the last two questions on the worksheet extend the ideas.

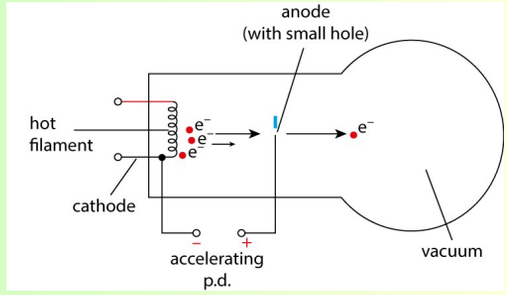
Energy, power and resistance	**Electron gun**
SHOULD (7)	Explain how an electron gun works

Mini-plenary: Yes or No?

Do all the electrons released go through the hole of the anode?

Do the electrons get faster after they've passed the anode?

Thinking question: why was a little hydrogen (or helium) gas sometimes put in the bulb?



Energy, power and resistance	**Electron guns**
COULD (8/9)	Calculate a value for the kinetic energy of an electron being emitted from an electron gun.

Task: page 144 summary q's 2-4

Deriving an equation for the velocity of an electron:

Work done on the electron = eV

Kinetic energy gained = $0.5mv^2$

$eV = 0.5mv^2$, and rearrange:

2 $eV = \frac{1}{2}mv^2$ therefore kinetic energy = eV [1]

kinetic energy = $1.60 \times 10^{-19} \times 12000$ [1]

kinetic energy = 1.9×10^{-15} J (2 s.f.) [1]

3 kinetic energy = $\frac{1}{2}mv^2$ therefore [1]

$v = \sqrt{\frac{2 \times 1.8 \times 10^{-15}}{9.11 \times 10^{-31}}} = 6.0 \times 10^{7}\ \text{m s}^{-1}$ (2 s.f.) [1]

4 $v = 0.09 \times 3.00 \times 10^{8} = 2.7 \times 10^{7}\ \text{m s}^{-1}$ [1]

$eV = \frac{1}{2}mv^2$ therefore $V = \frac{\frac{1}{2}mv^2}{e}$ [1]

$V = \frac{\frac{1}{2} \times 9.11 \times 10^{-31} \times \left(2.7 \times 10^{7}\right)^2}{1.60 \times 10^{-19}}$ [1]

$V = 2100$ V (2 s.f.) [1]

Energy, power and resistance		The electron gun
Learning objectives	MUST (6)	Describe uses for, and basic structure of, the electron gun
	SHOULD (7)	Explain how electron guns work
	COULD (8/9)	Calculate a value for the kinetic energy of an electron being emitted from an electron gun.

PLENARY: An electron is accelerated from rest across a potential difference of 100 V. What is its kinetic energy in:
a) electronvolts Charge of 1 e x 100 V = 100 eV
b) joules? 1.602×10^{-17} J

EXTENSION: An alpha particle is also accelerated from rest across a p.d. of 100 V. How will its:
a) kinetic energy = 200 eV, as the alpha particle has 2 x charge
b) velocity vary from the electron in the question above? 7344 times bigger (approx) so velocity much smaller - electron 60 times faster. Working below)

$$E_{k(\alpha)} = 2E_{k(e)}$$

$$0.5\, m_\alpha v_\alpha^2 = 2 \times 0.5\, m_e v_e^2$$

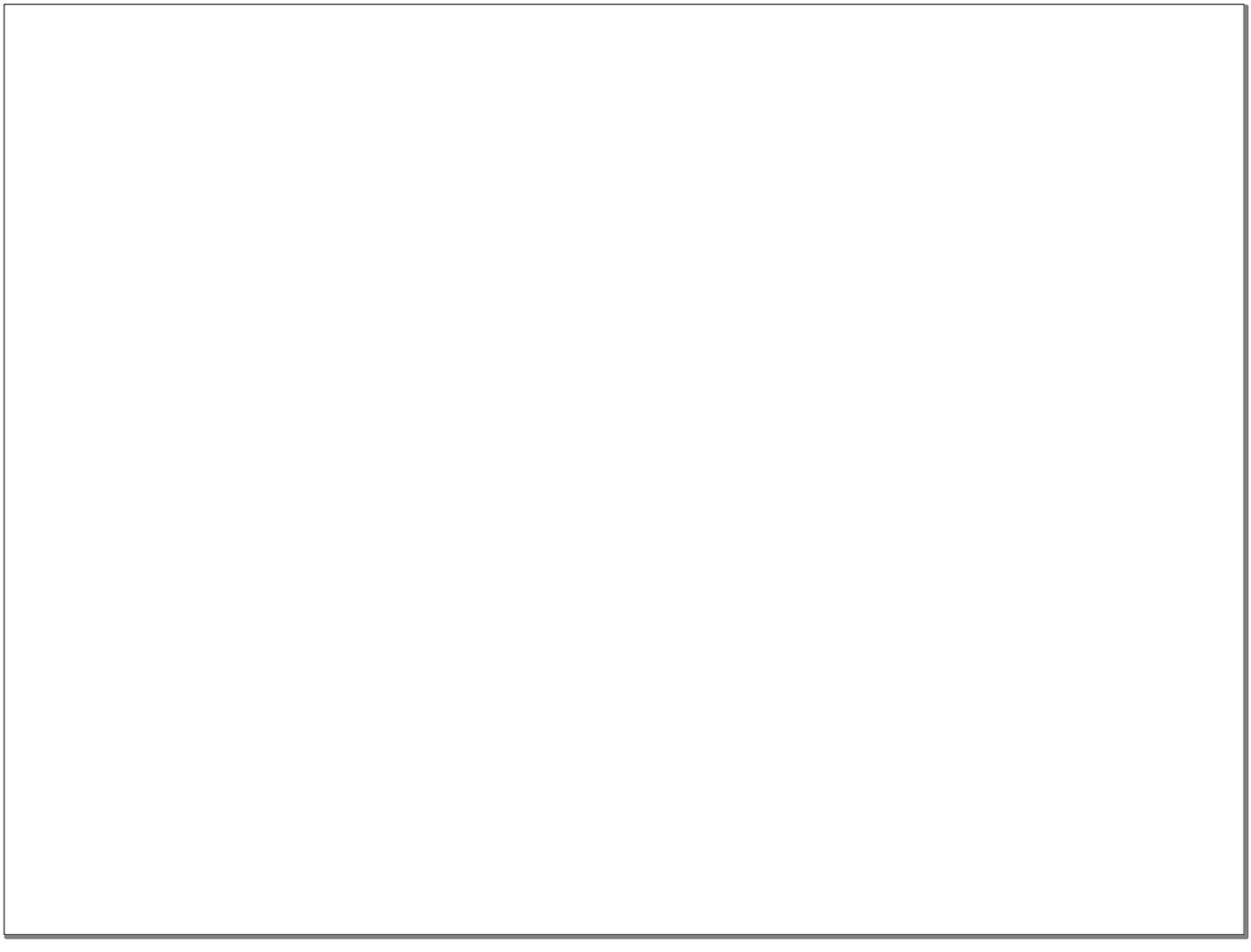
$$m_\alpha = 7344\, m_e$$

$$0.5 \times 7344\, m_e v_\alpha^2 = 2 \times 0.5\, m_e v_e^2$$

$$3672\, v_\alpha^2 = v_e^2$$

$$\sqrt{3672} = \frac{v_e}{v_\alpha}$$

Oct 16-21:59



Oct 4-00:04